GEL LOADING ADAPTER

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to an adaptor for multi-channel pipettors which allows for the use of gel-loading tips to simultaneously load multiple wells of a gel.

Related Art

[0002] Pipettors are used in laboratories to transfer small amounts of liquids (generally 1 ml or less) from one receptacle to another. In recent years the development of multi-channel pipettors, as shown, for example, in U.S. Pat. No. 4,824,642, has allowed for the simultaneous transfer of multiple samples. Because of the fixed spacing between the channels, the transfer of liquids must be made from one set of receptacles to another set of identically spaced receptacles. When it is necessary to transfer liquid from one set of receptacles to another set of receptacles with different spacing it becomes necessary to use a single channel pipettor. The individual transfer of many different samples using a single channel pipettor is a time consuming process.

[0003] This can be especially tedious when transferring liquid from receptacles, such as those of a 96 well plate. These plates are heavily used in assays, such as PCR amplification, sequencing, etc. Current technology allows for high volume sample preparation (i.e. the use of multi-channel pipettors to transfer multiple samples from multiple tubes). However, sample analysis in agarose/acrylamide gels still requires individual loading of each sample. Most multi-channel pipettors are configured to match the spacing of the wells on 96 well plates, but this spacing is different than the spacings generally used for the wells of acrylamide and agarose gels. Therefore, the transfer of samples from 96 well plates to

acrylamide or agarose gels using a multi-channel pipettor is not possible. These samples must be loaded one at a time into the wells of acrylamide or agarose gels, thereby greatly increasing the time and effort needed to perform research (e.g. sequencing, restriction digest analysis, genetic typing, etc.).

[0004] Acrylamide gels are polymerized between two glass plates which are separated by thin spacers on the side. Wells are made by inserting a thin comb at the top of the gel between the two plates before the acrylamide has set. These wells are loaded by pipetting the fluid into the well, being careful not to let the fluid seep into neighboring wells. Agarose gels, on the other hand, are cast in a gel-caster and, again, a comb is placed in the gel to form wells before the agarose is set. Once the agarose is set, it is placed in a gel electrophoresis apparatus filled with buffer and the comb is removed. Depending on the number of wells cast in the agarose, the loading of the samples is tedious and can result in errors if single channel pipetting devices are used.

[0005] Standard pipette tips are relatively rigid and wide and are difficult to use when loading acrylamide and agarose gels, which often times have narrow wells. Special tips for loading gels, as shown, for example, in U.S. Pat. No. 4,707,337, are much longer and more flexible than standard pipette tips. They also have a much thinner tip which allows them to load samples into narrow wells much more accurately. These tips are thin enough to fit in between the plates of a vertical gel and, thus, fluid can be delivered directly into the well, rather than from on top of the well with the fluid having to seep in between the two plates. Loading the fluid directly into the well greatly reduces the chances of the fluid seeping into neighboring wells.

[0006] In U.S. Pat. No. 5,061,449 and in U.S. Pat. No. 5,057,281, multi-channel pipettors capable of changing the spacing of the channels are described. These multi-channel pipettors contain 6 channels capable of being variably adjusted from being evenly spaced to being unevenly spaced apart. Adjusting these channels every time samples are transferred is very time consuming, especially if one transfers 96 samples from a 96 well plate to other differently spaced receptacles (this requires adjusting the channels 31 times - sixteen times to match the spacing of the receptacles to which the samples are transferred, and 15 *times*

to match the spacing of the 96 well plates). Furthermore, the channels of these adjustable multi-channel pipettors can not be adjusted to match a narrow spacing, such as the spacings between the wells of acrylamide gels. In addition, it is difficult to use gel-loading tips on these pipettors to deliver the samples with any accuracy due to the flexibility and length of the gel-loading tips.

[0007] Therefore, there is a need in the art for a device that allows one to simultaneously load multiple wells of a gel in which the spacing of the wells is different (or variable) from the available spacing on the multi-channel pipettors. As the requirement increases for denser loading arrays on gels (vertical, substantially vertical, horizontal, or substantially horizontal) there is a need for devices which can adjust spacing from 96 well microtiter plates to the required spacing in gels. The spacing between the wells of these gels depends on the combs used. Many combs that are commercially available provide variable well size and spacing. Thus, using a single comb, one might have four wells capable of holding only 50 μl of fluid and four wells capable of holding .5 ml of fluid. The present invention fulfills this need by allowing one to use multi-channel pipettors currently found in most laboratories to simultaneously load multiple wells of a gel using gel-loading tips. Multi-channel pipettors can cost hundreds of dollars. The prior art requires one to purchase new adjustable multi-channel pipettors, even though one might have a standard multi-channel pipettor at their disposal. Alternatively, the present invention costs a fraction of what a multi-channel pipettor costs. Thus, the present invention provides an inexpensive alternative to the prior art because it does not require the purchase of an expensive adjustable multi-channel pipettor.

SUMMARY OF THE INVENTION

[0008] The present invention relates to an adaptor for multi-channel pipettors which allows for the use of gel-loading tips to simultaneously load multiple wells of a gel. In particular, the present invention allows for the loading of vertical, substantially vertical, horizontal, or substantially horizontal gels. The adaptor of

the invention may also be used generally in any application involving fluid transfer from a first set of receptacles, containers, wells, tubes, etc., to a second set of differently spaced receptacles, containers, wells, tubes, etc.

[0009] In one aspect of the invention, an adaptor useful for transferring multiple fluid samples from a first set of receptacles (wells, tubes, containers, vials, etc.) spaced apart by a first spacing to a second set of receptacles (wells, tubes, containers, vials, etc.) spaced apart by a second evenly or unevenly spaced spacing is provided. The body of the adaptor is defined by a first set of apertures at one end of the body spaced apart by the first spacing and a second set of apertures at the second end of the body, remote from the first end, spaced apart by the second spacing or spacings. The second set of apertures are optionally disposed in an optional lip coupled to the second end of the body. Channels within the body connect the first set of apertures with the second set of apertures.

[0010] In another aspect of the invention, a multi-channel pipettor adaptor which includes a means for stabilizing and aligning the adaptor over a gel is provided. The means for stabilizing and aligning can include a base which can be attached to the multi-channel pipettor adaptor. This base has a top and two sides which straddle the gel. One or more guides (e.g. grooves, notches, etc.) are optionally provided in the base which allows the adaptor to be stabilized over a gel such that the second set of apertures are aligned with wells of a gel for loading samples. In one aspect of the invention, the base can slidably receive the adaptor of the invention. In a preferred aspect, the adaptor comprises one or more receiving guides for accepting one or more guides of the base.

[0011] In a further aspect of the invention, an assembly useful for transferring multiple fluid samples from a first set of receptacles (wells, tubes, containers, vials, etc.) spaced apart by a first spacing to a second set of receptacles (wells, tubes, containers, vials, etc.) spaced apart by a second evenly or unevenly spaced spacing is provided. This assembly is comprised of the body of the adaptor, which includes a first set of apertures at one end of the body spaced apart by the first spacing and a second set of apertures at the second end of the body, remote from the first end, spaced apart by the second spacing. In this aspect of the invention, channels connect the first set of apertures to the second set of

apertures, said channels comprising one or more gel-loading pipette tips inserted into said channels. In a preferred embodiment, such pipette tips are connected to a multi-channel pipettor.

[0012] In another aspect of the invention, an assembly useful for transferring multiple fluid samples from a first set of receptacles (wells, tubes, containers, vials, etc.) spaced apart by a first spacing to a second set of receptacles (wells, tubes, containers, vials, etc.) spaced apart by a second evenly or unevenly spaced spacing is provided. This assembly is comprised of the body of the adaptor, which includes a first set of apertures at one end of the body spaced apart by the first spacing and a second set of apertures at the second end of the body, remote from the first end, spaced apart by the second spacing, and a multi-channel pipettor inserted into the first set of apertures.

[0013] In yet another aspect of the invention, an assembly useful for transferring multiple fluid samples from a first set of receptacles (wells, tubes, containers, vials, etc.) spaced apart by a first spacing to a second set of receptacles (wells, tubes, containers, vials, etc.) spaced apart by a second evenly or unevenly spaced spacing is provided. This assembly is comprised of the body of the adaptor, which includes a first set of apertures at one end of the body spaced apart by the first spacing and a second set of apertures at the second end of the body, remote from the first end, spaced apart by the second spacing, and a base for stabilizing and aligning said adaptor over a gel. In a preferred embodiment, the adaptor/base is coupled such that the second set of apertures are aligned with wells of a gel for sample loading. Preferably, one or more gel-loading pipette tips are inserted into channels connecting the first set of apertures to the second set of apertures in said adaptor.

[0014] The adaptor of the invention may be used for any fluid delivery system. While multi-channel pipettors are preferred, automated robots designed to transfer fluid from one receptacle to another may also be used with the present invention. These types of robots are currently available on the market and have multiple components and capabilities. Many of these robots contain both a single channel pipettor and a multi-channel pipettor which can alternately be connected to the robots arm. These pipettors are arranged on a tray along with various

arrays of tubes and pipette tips. A computer controls the movements of the robot. The user would program the computer to let it know what types of tubes are being used, which pipettor should be used, and in what order the samples should be transferred. The arm of the robot will attach itself to one of the pipettor attachments (depending on which one it is programmed to attach to). If the robot needs to transfer liquid from one 96 well plate to another 96 well plate it should be programmed to use the multi-channel pipettor. If the robot needs to transfer liquid from 1 ml micro-centrifuge tubes to a 96 well plate, it should be programmed to use the single-channel pipettor.

[0015] The adaptor of the invention may be used as a component of the automated robot. The automated robot may be programmed to use the multi-channel pipettor, load gel-loading pipette tips onto the channels of the pipettor, pick up fluid from receptacles (wells, tubes, containers, vials, etc.) spaced apart by a first spacing, attach to the adaptor of the invention, and dispense the fluid into receptacles (wells, tubes, containers, vials, etc.) spaced apart by a second evenly or unevenly spaced spacing. In this way, the robot may be programmed to dispense the fluid into the wells of an agarose or an acrylamide gel. Thus, the adaptor of the invention is particularly suited for use in automated delivery of fluid samples.

[0016] In a further aspect of the invention, a method for transferring multiple fluid samples from a first set of receptacles (wells, tubes, containers, vials, etc.) spaced apart by a first spacing to a second set of receptacles (wells, tubes, containers, vials, etc.) spaced apart by a second evenly or unevenly spaced spacing that may be different from the first spacing is provided. This method includes: affixing gel-loading pipette tips onto a multi-channel pipettor; drawing fluid from the first set of receptacles (wells, tubes, containers, vials, etc.) into the gel-loading pipette tips; inserting the gel-loading pipette tips into an adaptor, the adaptor having a first set of apertures configured to interface with the first spacing, and a second set of apertures configured to interface with the second spacing; and dispensing the fluid from the gel-loading pipette tips so that the fluid flows through the adaptor into the second set of receptacles (wells, tubes, containers, vials, etc.). Preferably, the tips extend from the adaptor allowing fluid

to flow through the tips within the adaptor thereby avoiding fluid contact with the adaptor. In this manner, the adaptor may be used multiple times without the risk of having fluid from one pipetting contaminating later fluid samples.

[0017] In another aspect of the invention, a kit for transferring fluid from one set of receptacles (wells, tubes, containers, vials, etc.) to another set of receptacles (wells, tubes, containers, vials, etc.) which may have different spacing is provided. The kit comprises a carrier being compartmentalized to receive one or more components of the kit. The kit of the invention comprises one or more adaptors, which include a first set of apertures at one end of the body of the adaptor spaced apart by the first spacing and a second set of apertures at the second end of the body of the adaptor, remote from the first end, spaced apart by the second evenly or unevenly spaced spacing. The kit of the invention may further comprise one or more kit components selected from the group consisting of (i) one or more bases for stabilizing and aligning said body over a gel, (ii) one or more gel loading pipette tips, (iii) one or more multi-channel pipettors, and (iv) a gel electrophoresis apparatus (e.g. a vertical, substantially vertical, horizontal, or substantially horizontal gel electrophoresis apparatus).

[0018] It is a feature of the multi-channel pipettor adaptor that it can be attached to a multi-channel pipettor. It is a further feature of the adaptor that it can be attached to a base which straddles a vertical, substantially vertical, horizontal or substantially horizontal gel, thereby stabilizing and aligning the adaptor and multi-channel pipettor over the wells of the gel. It is yet a further feature of the adaptor that it can be attached to a vertical or substantially vertical gel, thereby aligning the adaptor and multi-channel pipettor over the wells of the vertical gel.

[0019] Another feature of the multi-channel pipettor adaptor is that it can be used together with an automated multi-channel pipettor. Thus, the multi-channel pipettor adaptor can be a component of an automated multi-channel pipettor device.

[0020] An advantage of the adaptor is that it allows the user to simultaneously load multiple wells of a gel accurately, thus providing better results and saving time.

[0021] A further advantage of the adaptor is that it allows the user to transfer multiple samples of fluid from a first set of receptacles (wells, tubes, vials, containers, etc.) spaced apart by a first spacing to a second set of receptacles (wells, tubes, vials, containers, etc.) which may be spaced apart by a second evenly or unevenly spaced spacing.

BRIEF DESCRIPTION OF THE FIGURES

[0022] The present invention is described with reference to the accompanying drawings. In the drawings, like reference numbers indicate identical or functionally similar elements. Additionally, the left-most digit of a reference number identifies the drawing in which the reference number first appears.

[0023] **FIG. 1A** shows a perspective view of one embodiment of a multi-channel pipettor adaptor of the present invention;

[0024] **FIG. 1B** shows a top view of the embodiment shown in FIG. 1A;

[0025] **FIG. 1C** shows a side view of the embodiment shown in FIG. 1A;

[0026] **FIG. 1D** shows a bottom view of the embodiment shown in FIG. 1A;

[0027] **FIG. 2A** shows a perspective view of one embodiment of a multi-channel pipettor adaptor of the present invention attached to a base to illustrate one embodiment of agarose gel loading; and

[0028] **FIG. 2B** shows a side view of the embodiment shown in FIG. 2A.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0029] The present invention is directed generally to an adaptor for multi-channel pipettors that allows the user to simultaneously transfer multiple samples from multiple receptacles (wells, tubes, vials, containers, etc.) having a first spacing to multiple receptacles (wells, tubes, vials, containers, etc.) having a second evenly or unevenly predetermined spaced spacing. In particular, the present invention has utility in transferring samples from sample holders to wells of a gel used in

gel electrophoresis. Such gels are used to separate and/or analyze proteins or nucleic acid molecules (e.g. DNA or RNA) or other biological materials. Typically, agarose or acrylamide gels are used in such procedures. In accordance with the invention, gel loading tips connected to a multi-channel pipettor are used to take up fluid from a number (two or more) of receptacles (wells, vials, tubes, containers, etc.) wherein the receptacles have a certain predetermined spacing. The adaptor of the invention provides a means of transferring the fluid to a second set of receptacles which may have a different spacing. Thus, the adaptor of the invention is used to either expand (enlarge) or contract (make smaller) the spacing needed for fluid transfer between the first set of receptacles to the second set of receptacles. Alternatively, the adaptor of the invention may be used without loading tips. In this embodiment, the multi-channel pipettor is connected to the adaptor and fluid is taken-up directly into and expelled directly from the adaptor.

[0030] The adaptor of the invention may be used for any fluid delivery system. While pipettors are preferred, automated fluid delivery systems, such as robots equipped with various pipettors and multi-tube arrays, can also be used with the adaptor of the present invention. In this embodiment, the adaptor would be a component of the automated fluid delivery systems. For example, the robot secures its arm to a multi-channel pipettor, loads gel-loading pipette tips onto the channels of the multi-channel pipettor, takes up fluid into the pipette tips from a first set of receptacles (wells, tubes, containers, vials, etc.) spaced apart by a first spacing, and then secures the multi-channel pipettor onto the adaptor of the invention. Having done this, the robot is able to transfer the samples to other receptacles (wells, tubes, containers, vials, etc.) spaced apart by a second evenly or unevenly spaced spacing. Thus, the adaptor of the invention is particularly suited for use in automation.

[0031] Turning now to FIG. 1A, an adaptor **100** having a body **104** is shown. Body **104** can be made from any of a variety of materials including, but not limited to, metal, glass, ceramic and plastic. Suitable plastics include acrylic compounds such as polypropylene, polycarbonate and polyester resin that can be used to form body **104** by injection or vacuum molding techniques. Body **104** can also be manufactured by welding a metal, such as aluminum, together to form

the base. Another technique would be to drill holes into a metal block or other material. Also, glass or ceramics can be used to form the body by injection molding. Other techniques and materials known to the skilled artisan can be used to form body **104**. The shape shown in the figures for body **104** is exemplary in nature, and it should be understood that the present invention is not limited to the illustrated shape. For example, body **104** can have a rectangular, trapezoidal, or other suitable shape.

[0032] As shown in FIG. 1B, an adaptor **100** includes apertures **101** at the top of body **104**. The present invention is not limited to the number of apertures **101** shown in the figures, but preferably includes at least two, more preferably two to one hundred, most preferably eight apertures. Apertures **101** may have any spacing and any arrangement depending on the need. For example, the apertures may be in a single row or multiple rows, arranged in a circle, square, rectangle, triangle, oval, etc. configuration. By way of illustration, the apertures may be configured to have the same spacing and configuration as a 96 well plate. Preferred spacing ranges from about 1 mm to 1000 cm, about 2 mm to 100 cm, about 5 mm to 10 cm, and about 5 mm to 10 mm. To match the spacing of the air channels on multi-channel pipettors, the spacing may range from about 7 to 11 mm and preferably about 9 mm. Apertures **101** are the starting points of channels **102**, as shown in FIG 1A. Channels **102** run the length of body **104** and exit through the same number of apertures **106** in a optional small lip **110** at the bottom of body **104**, as shown in FIG. 1D. Preferred spacing of apertures **106** may range from about 0.1 mm to 2000 cm, about 1 mm to 200 cm, about 2 mm to 20 cm, and about 2 mm to 10 mm. FIG. lC shows a side view of **104** and illustrates a receiving lip **108** and small lip **110**.

[0033] Exemplary dimensions of one embodiment of body **104** are as follows. The height of body **104** may be about 1 inch to 250 feet, more preferably about 2 to 3 inches, most preferably about 2.25 inches. The width of the top of body **104** may be about 1 inch to 350 feet, more preferably about 2 to 4 inches, most preferably about 2.8 inches. The width at the bottom of body **104** may be about 1 inch to 250 feet, more preferably about 1 to 3 inches, most preferably about 1.9 inches. Body **104** may be about 0.1 inches to 100 feet thick, more preferably

about 0.3 to 1 inch thick, most preferably about 0.5 inches thick. Receiving lip **108** may be about 0.1 inches to 50 feet wide, more preferably about 0.2 to .5 inches wide, most preferably about 0.3 inches wide, and may be about 0.1 inch to 20 feet in height, more preferably about 0.1 to 0.2 inches in height. Small lip **110** may be about 0.02 inch to 20 feet wide at the top, more preferably about 0.05 to 0.2 inches wide, most preferably about 0.1 inch wide, and may be about 0.1 inch to 70 feet wide at the bottom, more preferably about 0.3 to 0.7 mm wide, most preferably about 0.5 mm wide. The height of small lip **110** may be about 0.05 inch to 20 feet tall, more preferably about 0.1 to 0.2 inches tall.

[0034] In one embodiment of the invention, gel-loading pipette tips are affixed onto a multi-channel pipettor and fluid is drawn into them. The ends of the gel-loading pipette tips are inserted into apertures **101** at the top of body **104**. The tips are then threaded through channels **102** and exit body **104** through apertures **106** at the bottom of body **104**. The spacing of apertures **101** is preferably different from the spacing of apertures **106**. Apertures **101** are preferably evenly spaced about 7 to 11 mm apart, more preferably about 9 mm apart. Apertures **106** may be more narrowly spaced. Alternatively, apertures **106** may be wider and evenly spaced, or wider and variably spaced. Therefore, channels **102** may be configured as shown in FIG. 1A so that they curve inward toward the middle of body **104** to accommodate the difference in spacing between apertures **101** and apertures **106**. Channels **102** alternatively may be configured so that they curve outwards towards the sides of body **104**.

[0035] Channels **102** are also preferably configured so that each of the gel-loading pipette tips protrudes from small lip **110** the same distance. The tips toward the outer sides of body **104** travel the farthest, and therefore would protrude the least from small lip **110**. The tips in the middle of body **104** travel the least, and would protrude the most from small lip **110**. Thus, channels **102** toward the middle of body **104** must bend or increase the distance traveled by the pipette tips so that when the pipette tips protrude from small lip **110** they are even with the pipette tips toward the outer sides of body **104**.

[0036] Adaptor **100** is placed into the buffer reservoir of a vertical or substantially vertical gel box. Small lip **110** is placed between the two plates of a vertical or substantially vertical acrylamide gel and apertures **106** are then aligned correctly with the wells in the acrylamide gel. Gel-loading pipette tips affixed on a multi-channel pipettor are threaded through channels **102** and exit body **104** through apertures **106**. The fluid is then dispensed from the tips, and adaptor **100** is removed from the buffer reservoir of the gel box. Adaptor **100** can be removed manually from the multi-channel pipettor and the tips can then be ejected and disposed of.

[0037] In another aspect of the present invention, a means for stabilizing and aligning the adaptor over a vertical, substantially vertical, horizontal or substantially horizontal gel is provided. The means for stabilizing and aligning can include, for example, a base as described below with respect to FIGs 2A and 2B. The means for stabilizing and aligning the adaptor over a gel can also include a electrophoresis apparatus specially made to allow for the adaptor to be attached to it. Alternatively, a special attachment for the electrophoresis apparatus could be used to stabilize and align the adaptor over a gel. The means for stabilizing and aligning the adaptor over a gel can also include manually positioning the adaptor over the gel.

[0038] Turning now to FIG. 2A, the multi-channel pipettor adaptor **100** of the present invention is shown along with a base **200**. Base **200** can be made from any of a variety of materials including, but not limited to, metal, glass, ceramic and plastic. Suitable plastics include acrylic compounds such as polypropylene, polycarbonate and polyester resin that can be used to form base **200** by injection or vacuum molding techniques. Base **200** can also be manufactured by welding a metal, such as aluminum, together to form the base. Also, glass or ceramics can be used to form base **200** by injection molding. Other techniques and materials known to the skilled artisan can be used to form base **200**. The shape shown in the figure for base **200** is exemplary in nature, and it should be understood that the present invention is not limited to the illustrated shape. Base **200** is composed of a body **202** with a back **208**, two sides **210**, two horizontal support members **204**, and an angled ledge **212**. The shape shown in the figures for body

202, horizontal support members **204**, back **208**, side **210**, and angled ledge **212** are exemplary in nature, and it should be understood that the present invention is not limited to the illustrated shape. For example, body **202** can have a triangular, rectangular, trapezoidal, or other suitable shape. Horizontal legs **204** may have a semi cylindrical, rectangular, or other suitable shape.

[0039] Angled ledge **212** has one or more grooves **206** which run the length of the hypotenuse of angled ledge **212**. FIG. 2B shows a side view of base **200** and body **104** and illustrates how the two are secured to one another. The body **104** is secured to the base **200** by inserting receiving lip **108** into groove **206**. Optionally, angled ledge **212** may have multiple grooves to accept multiple lips on a multi-channel pipettor adaptor.

[0040] Turning back to FIG. 2A, base **200** is positioned over a horizontal gel by inserting horizontal support members **204** into the receiving channels **207** on the side of a horizontal gel caster which has already been submerged in buffer in the buffer chamber of a gel electrophoresis apparatus. Body **104** is then attached to base **200** by inserting receiving lip **108** into groove **206** with small lip **110** hanging over the side of body **202**. Body **104** is then centered on base **200** by sliding the body **104** so that the apertures **106** are aligned with the wells **214** of the gel. In a manner similar to that described above, gel loading tips are affixed onto a multi-channel pipettor and fluid is drawn into them. The tips are then inserted into apertures **101** on top of body **104**. The tips are threaded through channels **102** and exit body **104** through apertures **106** at the bottom of body **104**. The fluid in the tips is then dispensed into the wells **214**. The multi-channel pipettor is then removed from body **104** and the gel loading tips are ejected and disposed of. Body **104** may then either be removed from base **200** or slid further down the base **200** so that subsequent wells may be loaded with samples.

[0041] While the foregoing invention has been described in some detail for purposes of clarity and understanding, it will be appreciated by one skilled in the art from a reading of this disclosure that various changes in form and detail can be made without departing from the true scope of the invention and appended

claims. All publications, patent applications and patents cited herein are fully incorporated by reference herein in their entirety.